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UNITED STATES DEPARTMENT OF AGRICULTURE

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THE WOOLLY-POD MILKWEED (ASCLEPIAS ERIOCARPA) AS A POISONOUS PLANT.

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Many statements have been made by California stockmen in regard to the loss of range animals, especially sheep, by milkweeds. These statements generally were not in regard to any particular species, but simply about plants popularly known as milkweeds. That these losses actually occurred there was no doubt, and there seemed as little doubt that they might be connected with particular species. Department Bulletin No. 969 of the United States Department of Agriculture deals specifically with the Mexican whorled milkweed, which has a widespread distribution in California, and shows conclusively its extremely poisonous character. Among other milkweeds the woolly-pod milkweed, *Asclepias eriocarpa*, has been supposed to be connected more or less definitely with losses of sheep. Through the kindness of Prof. H. M. Hall, of the Carnegie Institution, Washington, D. C., a considerable quantity of this plant was obtained and experimental work carried out in some detail, which has cleared up the facts in regard to the poisonous properties of the plant. The work is the subject of this bulletin.

Very little has been published in regard to the poisonous properties of *Asclepias eriocarpa*. Apparently the first statement in print was that made in 1890 by Prof. E. W. Hilgard in The Weeds of California, in which he states:

> *A. fremonti and eriocarpa*, and locally *Gomphocarpus tomentosus*, maintain themselves in pastures, to the occasional detriment of sheep and cattle that are tempted to vary their dry summer diet with something green, and are poisoned by eating the leaves of these milkweeds.

63982°—24

In 1898 Chesnut's Preliminary Catalogue of Poisonous Plants was published, in which he makes the following statement:

Asclepias eriocarpa Benth.—This is the plant with broad mullein-like leaves which is known as milkweed in California. Several authentic accounts of the poisoning of sheep have been secured against the plant in Mendocino County. It is especially feared on very warm days by sheep men when they are compelled to drive their flocks through dry, barren valleys. It sometimes grows on cultivated land and is cut with hay.

Professor Chesnut had traveled somewhat extensively in California and had gathered considerable data in regard to the poisonous properties of this plant, upon which the foregoing statement was based. In 1902 J. B. Davy, in his bulletin Stock Ranges of Northwest California, said: "Several cases of sheep poisoning have been recorded against the plant in Mendocino County."

In 1910 Pammel, in his Manual of Poisonous Plants, quoted Chesnut as authority for the poisonous properties of *Asclepias eriocarpa*. Jepson, in his Flora of West and Middle California (1911), says that *Asclepias eriocarpa* is said to poison sheep. Other authors have mentioned *Asclepias eriocarpa* as one of the supposed poisonous milkweeds, but apparently all the definite information that has been published was based largely on the investigations made by Chesnut.

Recent systematic studies of the species of Asclepias by W. W. Eggleston, of the Bureau of Plant Industry, show that probably some authors did not distinguish between *A. eriocarpa* and *A. fremontii*, so that the preceding statements do not in all cases refer to the true *A. eriocarpa*.

DESCRIPTION OF THE PLANT.[1]

Woolly-pod milkweed, *Asclepias eriocarpa*, shown in Figure 1, is a woolly herb with an erect angular stem from 6 inches to 3 feet high. It is white-woolly even to the outside of the corolla, becoming deciduous. The leaves are opposite or three or four together, the upper often alternate, broadly oblong to lanceolate, from 4 to 8 inches long, obtuse or subcordate at base, rounded or acute at apex, short petioled; the umbels are few or several, on peduncles equaling or longer than pedicels; the flowers are creamy-white, 3½ lines long; hoods with slight purplish tinge, shorter than the anthers, cleft a short distance down the back, the acute sickle-shaped horn little protruded from between the acute teeth of the cleft. It occurs in dry ground. It has been reported from Mendocino and Lake Counties, Calif., and extends southward through the coast ranges to the southern part of the State.

The following key will serve to distinguish this milkweed from the nearly related species which are found in California.

KEY.

Stems prostrate, strongly flattened——*Solanoa purpurascens* (Gray) Greene.
Stems erect, round in cross section.
Hoods without horns——*Gomphocarpus.*
Plant glabrous——*G. cordifolius* Benth.
Plant hairy——*G. californicus Greene.*

[1] The description of the plant and the accompanying key were prepared by W. W. Eggleston, of the Bureau of Plant Industry.

Stems erect, round in cross section—Continued.
Hoods with horns_____*Asclepias.*
Lateral umbels sessile; terminal umbel with peduncles; southern California_____*A. vestita* Hook. & Arn.
Umbels with pedicels.
Leaves opposite.
Leaves petioled; northern California_____*A. fremontii* Torr.
Leaves sessile; southern California_____*A. erosa* Torr.
Leaves often three in whorl_____*A. eriocarpa* Benth.

FIG. 1.—A branch of woolly-pod milkweed, *Asclepias eriocarpa*, showing the forms of the leaves and flowers.

EXPERIMENTAL WORK.

During the summer of 1922 feeding experiments with *Asclepias eriocarpa* were made on 2 head of cattle and 19 sheep. The material, mixed with hay, was fed to the cattle, 3 of the sheep were fed in a similar way, 2 of them received it with hay and bran, and the other 14 were given the material by balling gun. In all cases the material was fed dry but the dosage was computed in terms of the green plant. In Table 1 the experimental work with the plant is summarized.

TABLE 1.—*Summary of feeding experiments with Asclepias eriocarpa, Salina (Utah) Experiment Station, 1922.*

Animal.		Date of feeding.	Method of feeding.	Part of plant used.	Weight of plant, estimated as green plant per 100 pounds of animal.	Results.	Place and date of plant collection.
Designation.	Weight.						
Cattle:	*Pounds.*	1922			*Pound.*		
No. 938	400	Sept. 18	In hay	Leaves	0.2	Very sick	Fresno County, Calif., Oct. 13, 1921.
No. 928	408	Sept. 21	do	do	0.1	Symptoms	Do.
Sheep:							
No. 664	111	June 20	Balling gun.	do	0.5	Death	Do.
No. 663	103.75	June 24	do	do	0.25	Possible symptoms.	Do.
No. 666	93.5	June 26	do	do	0.3	Death	Do.
No. 667	142.5	June 28–29	In hay	do	0.2	Not sick	Do.
No. 695	105	June 29	Balling gun.	Stems	0.3	Death	Do.
No. 685	102.5	July 5	do	Leaves	0.26	Sick	Do.
No. 672	80.5	July 8	do	Water mark of leaves.	0.62	Not sick	Do.
No. 691	106.25	July 15	do	Leaves	0.25	Very sick	Do.
No. 651	115	July 19	do	Stems	0.1	Probable slight symptoms.	Do.
No. 683	103.25	July 24	do	do	0.2	Not sick	Do.
No. 680	110.25	July 27	do	Leaves	0.2	Symptoms	Do.
No. 662	98.75	July 31	do	do	0.21	Not sick	Do.
No. 572	123	Aug. 3	do	Stems	0.21	Possible symptoms.	Do.
No. 670	124.25	Aug. 7	do	Leaves	0.22	Death	Do.
No. 668	103	Aug. 10	do	do	0.2	Symptoms	Do.
No. 677	103.25	Aug. 16–18	With hay	do	0.3	Depressed	Do.
No. 699	118.5	Aug. 20–21	do	do	0.24	Not sick	Do.
No. 662	105	Aug. 25	With bran and hay.	do	0.21	Possible symptoms.	Do.
No. 675	112.25	do	do	do	0.4	Sick	Do.

TYPICAL CASE OF SHEEP 691.

Sheep 691, a ewe about 4 years old, weighing 106.25 pounds, was brought in from the pasture on July 12. She was kept under observation until the feeding with *Asclepias eriocarpa*, which was made at 2.12 p. m. on July 15. From the morning of July 13 to the morning of July 14 she was kept in the metabolism cage for the collection of urine. Regular clinical observations on temperature, pulse, and respiration were made in the preliminary period. The feeding of dried plant was made by balling gun. Estimated as green plant this would have been 0.25 pound per hundredweight of animal.

On July 15 no symptoms appeared.

On July 16, at 6.45 a. m., the animal was distinctly depressed. The depression continued throughout the day. During the day, too, the temperature fell, reaching 100.20° F. in the morning and being much below normal during the day, as shown in the curve, Figure 6. At that time also the pulse and respiration were considerably more rapid than normal. At times during the day the animal groaned and the respiration was more or less labored. These symptoms continued on July 17, the respiration being more labored and the pulse rapid and weak.

From the morning of July 17 to July 18 she was kept in the metabolism cage for collection of urine. During July 17 there was a marked increase in temperature, rising to 104.9° F. This was a jump from the low temperature of 100.4° F. of the preceding day.

July 18. In addition to the symptoms noted on the preceding days, the feces were liquid and contained much mucus, and there was a heavy mucous secretion from the nose. The sheep was weak and lay down most of the time.

July 19. In the morning the feces were found to contain not only mucus but some blood. The animal would stand only when urged to do so. Up to that time the animal had eaten nothing since the definite symptoms appeared. She was strong enough to keep on her feet, but did not stand voluntarily.

July 20. The feces continued of the same character and had a very offensive odor. There was some trembling of the head, neck, and flanks, and the animal was weaker than on the preceding day.

July 21. While the general symptoms continued as before, the animal seemed less depressed and in somewhat better condition. There was a drop in temperature from the preceding days, more nearly approaching normal.

July 22. The improvement in the general condition continued and when turned into the pasture in the morning she commenced to feed. The feces were less liquid than during the acute time of the sickness, and the animal seemed fairly strong, although distinctly "gaunted." During the day she apparently continued to feed and was able to get about fairly well.

July 23. She was again turned into the pasture with the other animals and continued with them.

July 25. It was noted that she had gained in weight and had made very marked improvement, the depression having almost entirely disappeared.

July 29. She was found dead, having been caught between two trees. Presumably she was too weak to extricate herself. Had it not been for this accident she probably would have recovered completely.

The autopsy was made in the morning, the noticeable lesions being the congested lungs and duodenum. The spleen was soft and the gall bladder was distended with gas, the bile being somewhat thickened. As the animal had been dead for some time, some of the changes in tissue may have been due to post-mortem effects.

The photographs for Figures 2, 3, 4, and 5 were taken on July 19 and show very clearly the depressed and weakened condition of the animal.

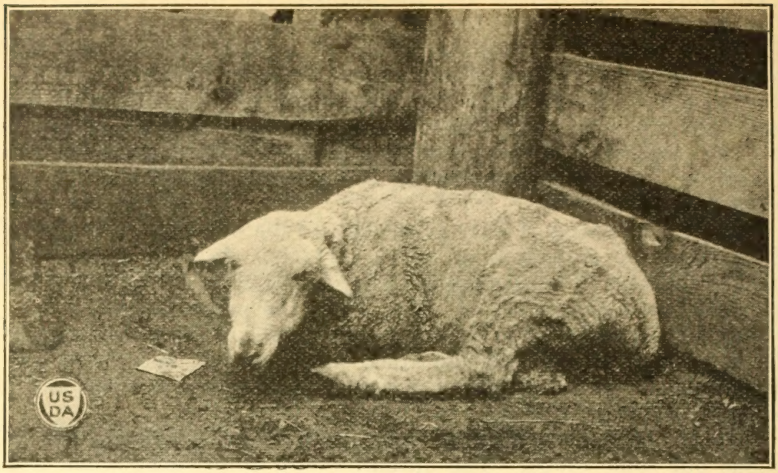

FIG. 2.—Sheep 691 at 8 a. m., July 19, showing marked depression.

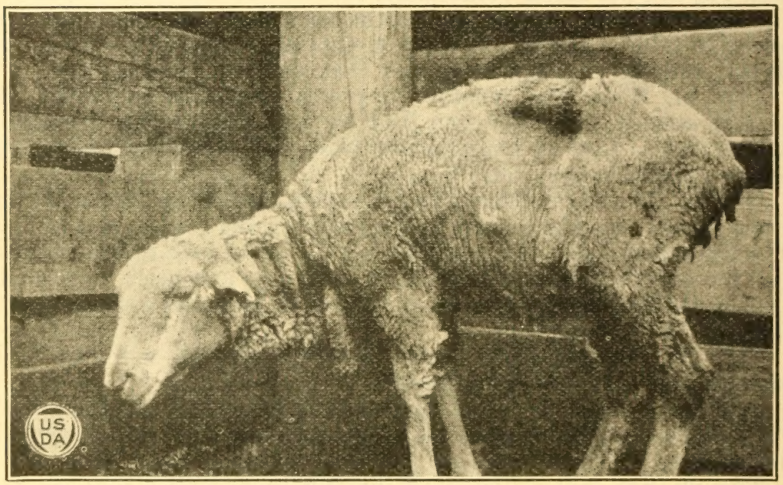

FIG. 3.—Sheep 691 just after 8 a. m., July 19, showing depression more markedly than in Figure 2.

RESULTS OF EXPERIMENTAL WORK AND CONCLUSIONS.

SYMPTOMS.

Ordinarily the first marked symptom was depression. All the sick animals exhibited it, and in those that were severely poisoned it was accompanied by weakness and in two cases by trembling. Some of the animals, while standing, were in a "humped-up" position, indicating some pain. The pulse in the very sick animals was rapid

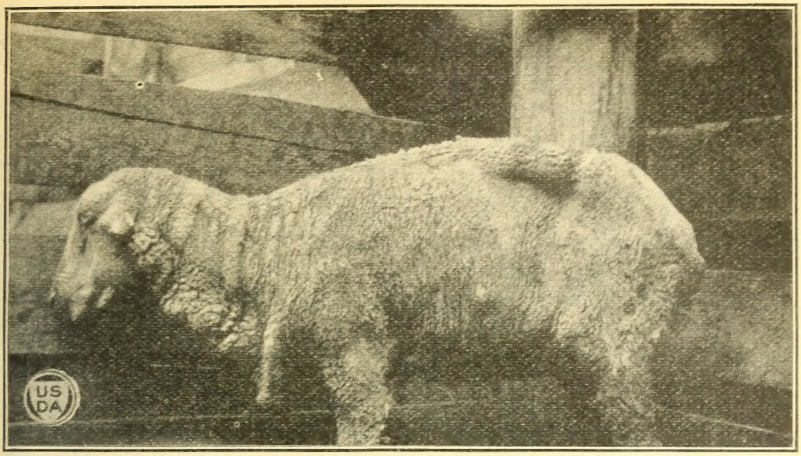

FIG. 4.—Sheep 691 at 9.55 a. m., July 19. The animal was very weak and stood only under compulsion.

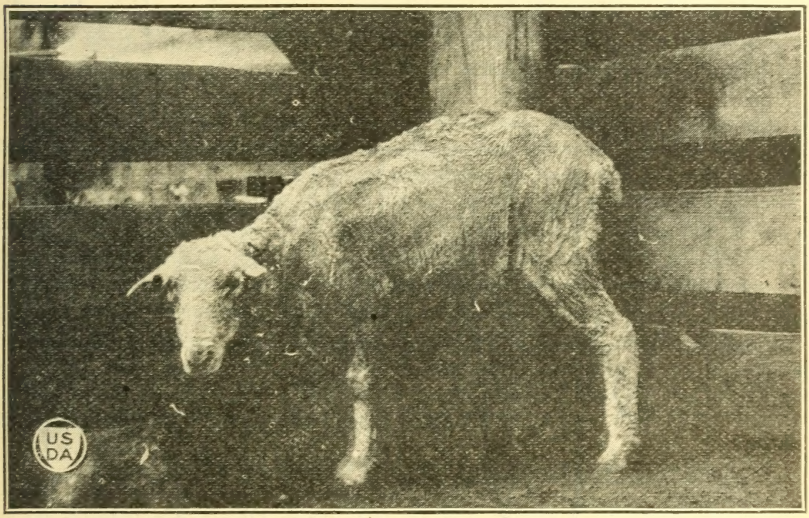

FIG. 5.—Sheep 685 at 10.40 a. m., July 6. Weakness is indicated by the lowered head, humped back, and outspread hind legs.

and at times weak and thready. However, there was nothing in the character of the pulse or its rate that could be considered as peculiar to poisoning by *Asclepias eriocarpa*.

The respiration in the milder cases was entirely normal, but in some of the very sick animals there was marked dyspnœa. In the period immediately before death this labored breathing was frequently accompanied by groans.

In most of the animals, following the first acute period of poisoning, there was marked diarrhea, the feces being soft, containing much mucus and sometimes more or less blood.

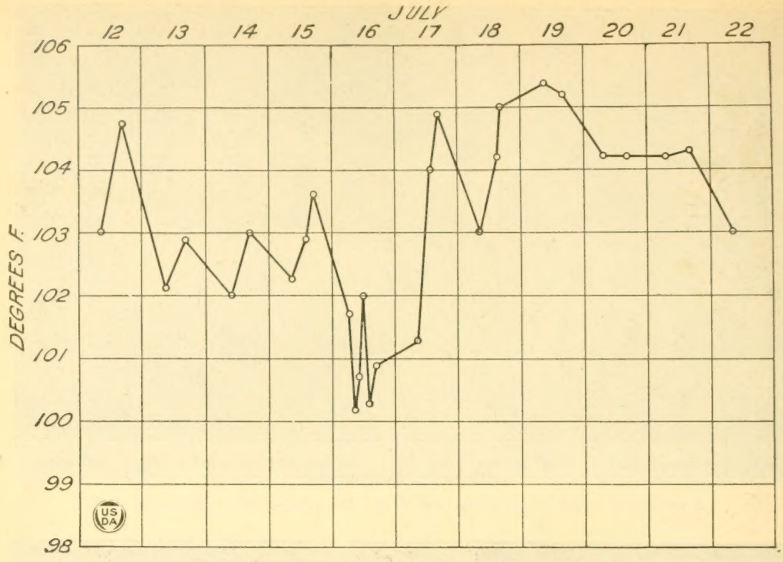

FIG. 6.—Temperature curve of sheep 691.

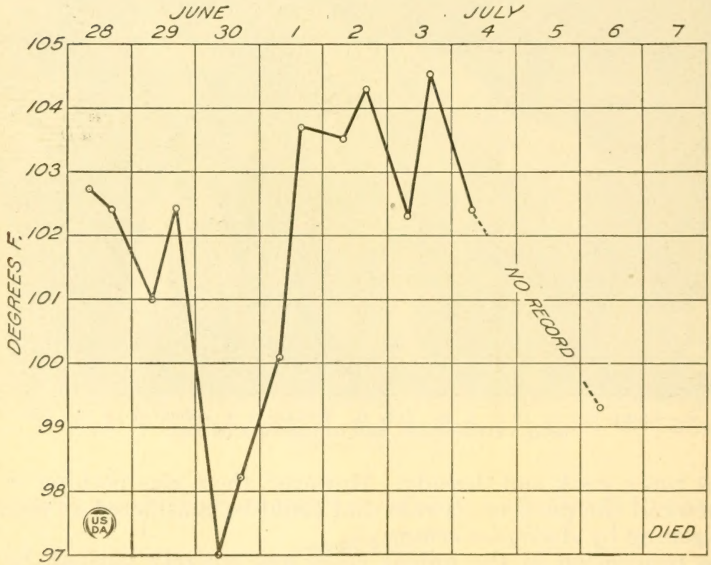

FIG. 7.—Temperature curve of sheep 695.

The temperature showed certain distinctly characteristic changes. It was taken twice a day, early in the morning and late in the afternoon. Of 18 cases in which observations were made, 3 showed no

change. Of these 3 only 1 was distinctly poisoned. Four animals exhibited a more or less distinct rise in temperature. Of these 4, 2 had only symptoms of poisoning. Eleven of the eighteen cases had a lowered temperature after the feeding. This was most marked in sheep 680, 663, 664, 695, 691, and cattle 928. The lowest temperatures noted were 98° F. in cattle 928, 99° in sheep 663 and 664, and 97° in sheep 695.

This lowered temperature was ordinarily followed by a period of high temperature. The highest noted were 103.6° in sheep 668, 104.5° in sheep 695, and 105.4° in sheep 691. Figures 6 and 7 illustrate this in the temperature curves of sheep 691 and 695. It may be noted that the low temperatures were distinctly subnormal, while the higher temperatures can not be considered as abnormal, although they were higher than the average temperatures of the animals. The temperature picture was not of an entirely uniform character, but in most cases three phases could be more or less clearly distinguished. Within 24 hours after a feeding there was a fall in temperature to a point in most cases clearly subnormal. This was followed, generally within a 24-hour period, by a time in which the temperatures were slightly higher than normal. In the third period in which normal temperature was gradually restored, there was frequently an unusual degree of diurnal variation. It is in the second period that the animals are most likely to suffer from diarrhea, and that condition may account to some extent for the slightly higher temperature.

In general, the course of symptoms was about as follows: The first symptom was depression accompanied by a rapid and ordinarily weak pulse and a lowered temperature. These symptoms appeared several hours after the administration of the plant—sometimes as long after as 24 hours. In severe cases there was dyspnœa, groaning, and some evidence of pain, followed by a period of higher temperature and inflammation of the alimentary canal, resulting in a more or less clearly marked diarrhea in which the feces showed mucus and sometimes blood. The animals which died grew gradually weaker, with no other marked symptoms, and died quietly with no spasms and no period of coma. Recovery in all cases was a slow and gradual process, sometimes requiring a week.

DELAY IN DEVELOPMENT OF SYMPTOMS.

In Table 2 is shown the time which elapsed between the feeding of the plant and the development of symptoms. As sheep 572 was a somewhat doubtful case with a single observation only, it is not included in the table, nor in Table 3.

The time in the case of the two cattle used was nearly the same, averaging 21 hours and 36 minutes. In the sheep the minimum was 3 hours 23 minutes and the maximum 22 hours 35 minutes. The average time did not differ much from that of the four species of

whorled milkweeds as reported in Department Bulletin 969. In the minimum and maximum limits it resembled *Asclepias galioides*, with which it was about equally toxic.

TABLE 2.—*Time from feeding to symptoms.*

Animal.	Time elapsed before symptoms.		Animal.	Time elapsed before symptoms.		Animal.	Time elapsed before symptoms.	
Cattle:	*Hours.*	*Minutes.*	Sheep—Con.	*Hours.*	*Minutes.*	Sheep—Con.	*Hours.*	*Minutes.*
No. 938	21	50	No. 685	10	13	No. 662	16	35
No. 928	21	23	No. 691	16	33	No. 675	16	35
Sheep:			No. 651	17	46			
No. 664	3	24	No. 680	18	36	Average (cattle).	21	36
No. 663	22	2	No. 670	10	55	Average (sheep).	15	28
No. 666	3	23	No. 668	21	39			
No. 695	20	53	No. 677	22	35			

DURATION OF SICKNESS.

Table 3 shows the time the sickness continued in those animals which recovered. As in Table 2, sheep 572 is not included. The table includes only those animals in which it was considered that the symptoms were positive. The times are from the first recorded symptoms to the last. The actual periods would be longer rather than shorter.

TABLE 3.—*Duration of sickness in cases of recovery.*

Animal.	Duration of symptoms.			Animal.	Duration of symptoms.		
Cattle:	*Days.*	*Hours.*	*Minutes.*	Sheep—Continued.	*Days.*	*Hours.*	*Minutes.*
No. 938	7	1	.....	No. 668	.....	23	40
No. 928	1	9	30	No. 677	1	2	10
Sheep:				No. 662	.....	1	10
No. 663	1	1	41	No. 675	4	9	30
No. 685	2	2	15				
No. 691	7	1	40	Average (cattle)	4	5	15
No. 651	1	8	13	Average (sheep)	2	1	28
No. 680	.....	10	50				

The average duration in the sheep, 2 days 1 hour and 28 minutes, did not differ widely from that of *A. mexicana*, *A. pumila*, and *A. verticillata* var. *geyeri*, as shown in Department Bulletin 969.

The longest periods were in cattle 938 and sheep 691, both of which were very sick. Sheep 662 had the shortest period, 1 hour and 10 minutes, and showed only symptoms. Of the others, sheep 685 and sheep 675 were most affected and were sick longer than those which had simply symptoms. Generally speaking, the duration of illness was correlated with the degree of sickness.

Only two cattle were used, and a larger number of experiments might have materially altered the average of these animals.

Table 4 shows the time elapsing between the feeding and death in the cases which terminated fatally.

Sheep 670 was sick the shortest time, 9 hours and 50 minutes. Sheep 695 had the longest period of illness, 6 days and 22 hours. The average time of all fatal cases, 2 days 6 hours and 43 minutes,

TABLE 4.—*Duration of sickness in fatal cases.*

Animal.	Duration of symptoms.		
Sheep:	*Days.*	*Hours.*	*Minutes.*
No. 664	1	3	48
No. 666		15	15
No. 695	6	22	
No. 670		9	50
Average	2	6	45

is a long time for the effect of a single small dose of a poisonous substance to continue. It shows that the plant produces a profound effect upon the system.

AUTOPSY FINDINGS.

Autopsies were made on five sheep. In each there was congestion in the fourth stomach and ileum. In single cases there was some congestion in other parts of the alimentary canal, for example, in rumen, reticulum, and cecum. The lungs were congested in four cases and the kidneys in three. It will be seen that the picture was not especially characteristic.

In general, the lesions consisted of congestion of the lungs, kidneys, and portions of the alimentary canal, the last being most marked in the duodenum.

MICROSCOPIC CHANGES IN TISSUES.

The microscopic examination of the tissues brings out in greater detail the changes which were noted in the autopsies and presents certain additional facts.

Many portions of the alimentary tract were affected. In the mucosa of various parts of the small intestines there was an edematous condition, and, in all cases examined, lymphocytes and sometimes polymorphonuclear leucocytes were much more abundant than normal.

In the wall of the fourth stomach an outwandering of leucocytes had occurred. This was especially noticeable near the border line between the mucosa and the submucosa. In this region, too, the blood vessels were somewhat distended. This condition was less marked in the cases of short illness, but in sheep 695, which lived for nearly eight days, it was very pronounced and the submucosa was greatly thickened by a serious exudate.

The wall of the second stomach was thickened in two of the cases. In the case of shorter illness the epithelial cells of the mucosa were swollen, a great proportion of them necrotic, and the area infiltrated with leucocytes. In the connective tissues there was pronounced edema. In the more prolonged case the mucosa and submucosa were represented by a greatly thickened mass of granular débris. The muscle layers were also thickened, the muscle bundles being pushed apart by the tremendously distended and ruptured blood vessels and the marked accumulations of serum and leucocytes.

A somewhat similar condition was found in the first stomach of one case and the third stomach of another.

Of the glandular organs, the kidneys were the most severely affected, the conditions being of the acute parenchymatous nephritis type. The convoluted tubules were the most severely attacked. In one case few nuclei were apparent in epithelial cells of these tubules. In the case of sheep 695 there were numerous casts in the collecting tubules, and most of the tubules of the medullary rays were greatly distended, the distension giving the epithelial cells a flattened appearance. The epithelial cells lining the capsule of Bowman and covering the glomerular tufts were swollen and in some instances had undergone marked granular degeneration.

In the liver the changes in the hepatic cells, as a rule, were not very severe. The cytoplasm was somewhat more granular than normal and an occasional cell apparently was necrotic. The bile ducts, especially the larger ones, had a swollen epithelium. The cells were more or less loosened from the basement membrane, and many of them were necrotic. Cells and groups of cells frequently were lying in the lumen of the duct. In many cases the capillaries surrounding the ducts were distended and the neighboring tissue edematous and infiltrated with leucocytes. The interlobular portal sheaths were edematous and in some areas were richly infiltrated with leucocytes.

Lymph glands in different parts of the body were affected. The branched reticular cells of the lymph spaces were uniformly swollen and often contained an abundance of granular material. In the lymph spaces, swollen and degenerated large mononuclear cells, lymphocytes, and sometimes polymorphonuclear leucocytes were abundant. Some small-cell groups, apparently of phagocytic cells, were necrotic. In most cases the trabeculæ and capsule were edematous and infiltrated with leucocytes, many of which were degenerated. The glands frequently were congested and some were hemorrhagic, the hemorrhages being most abundant in the cortex.

The spleens of two of the four cases examined were severely congested and their pulp cells showed marked degeneration. Many necrotic nuclei were scattered throughout the mass of red blood corpuscles.

While no marked changes were apparent in the muscle cells of the heart, there was a general edematous condition of the connective-tissue areas. In many places round-cell infiltration had occurred. While these cells were most plentiful in the areas where connective tissue is most abundant, in some places they were lying between the muscle fibers in considerable numbers.

The arteries and to a less extent the veins of the lungs contained an excess of blood in which small aggregations of leucocytes were sometimes present. While in some small, restricted areas the pulmonary capillaries were distended with blood, as a rule they were more or less contracted.

In summarizing the findings of the autopsies and microscopic studies, it appears that the most outstanding features are the evidences of irritation in various parts of the alimentary tract and in the kidneys. This condition was very severe in the wall of the second stomach of two of the cases, and in the third stomach of one, and appeared in a milder form in the fourth stomach and the small intestines of all. The changes were somewhat severe in the kidneys and

less marked in the liver and lymph glands. Effects of the irritant were also present in the loose connective tissues of most of the organs examined.

TOXIC AND LETHAL DOSAGE.

The smallest quantity that produced a toxic effect in sheep was 0.1 pound per hundredweight of animal, in the case of sheep 651. This animal was fed by balling gun. As sheep 683, fed in the same way, received 0.2 pound with no positive symptoms, and sheep 662, 0.21 pound with no effect, it would appear that 0.1 pound per hundredweight is about the minimum toxic dose, while an animal may receive twice as much with no untoward result. The smallest lethal dose was 0.22 pound per hundredweight of animal in sheep 670.

It is evident that there is no very marked difference between the toxic and lethal doses.

Of the two head of cattle used, No. 938 was made very sick on 0.2 pound per hundredweight of animal, and No. 928 showed symptoms on 0.1 pound. It appears that, compared with the weight of animal, the dosage of cattle was practically the same as that of sheep.

The plant is shown to be very poisonous. As compared with the whorled milkweeds, which are discussed in Department Bulletins 800, 942, and 969, it has a dosage much like *Asclepias galioides*.

COMPARATIVE TOXICITY OF LEAVES AND STEMS.

Four of the experimental animals were fed with the stems of the plant. All the others received leaves. So far as this number of feedings is concerned, it appears that the stems and leaves are equally toxic.

ANIMALS AFFECTED.

The experimental work was with cattle and sheep and it is shown that both classes are susceptible to poisoning by woolly-pod milkweed. There are no data in regard to its possible effect on horses; no reports of poisoning of horses have been received, but it is probable that they, as well as cattle and sheep, may be poisoned.

All the experimental work was done with dried plant. It is evident that the woolly-pod milkweed may be a dangerous element in hay, for in some localities it grows so abundantly that considerable quantities may be gathered with the hay.

SUMMARY.

Woolly-pod milkweed (*Asclepias eriocarpa*), a plant growing rather abundantly in parts of western California, has been suspected of being poisonous to sheep. It has been shown to be very poisonous not only to sheep but also to cattle.

While animals are not likely to eat it except when other forage is scarce, it is dangerous because of its especially toxic character, for as little as 0.1 of a pound per hundredweight of animal may poison, and 0.22 of a pound may cause death.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

January 9, 1924.

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